Marble and Hydrochloric Acid Investigation

Aim:
The aim in this investigation is to see how the concentration of hydrochloric acid, effects the rate in which marble dissolves.

Theory (back ground info):
There are four ways in which you can speed up the rate of reaction:

1) Using a catalyst
2) Increasing the temperature
3) Increasing surface area of a solid substance
4) Increasing the concentration of a liquid

1) A catalyst is a substance that increases the rate of reaction with out getting used up, for example getting an A4 piece of paper and ripping it up will take to long but if you get scissors it would be a lot quicker, also the scissors do not get used up they can be used again for next time.

2) Increasing the temperature of a substance increases the amount of kinetic energy the particles have. This then allows reacting particles to collide at a faster rate, e.g. if you heat a bar of metal from a low temperature to a high temperature it will melt quicker.

3) Increasing the concentration of a liquid.

Key:

A= Weak acid concentration

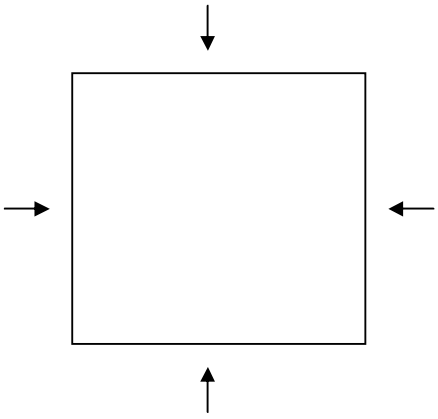
B= Strong acid concentration

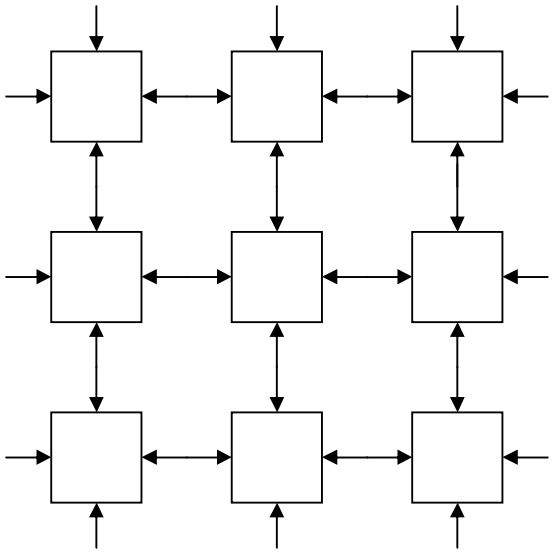
With 2m concentration of acid, there are more acid particles in the liquid, therefore there is more chance of acid particles moving around and colliding with the lump of marble. Increasing the rate of reaction. A prime example of this is the investigation we are doing now, with the hydrochloric acid (HCL) and Marble i.e. calcium carbonate ($CaCo_3$).

4) Increasing the surface area of a substance is the last way of speeding up the rate of reaction.

Key:

→ Acids attacking the surface of the metal





The more surface there is the more sides there is for the acid to attack and react with at one time. This speeds up the rate of reaction (I managed to recover this useful information for my theory from spotlight science).

The chemical names for marble and hydrochloric acid are:

Calcium Carbonate $CaCo_3$ and hydrochloric acid HCL
The word equation for this investigation is:

Calcium Carbonate+Hydrochloric acid ⟶ Calcium Chloride+Water+Carbon Dioxide

The Chemical equation for this investigation is:

$CaCo_3 + 2HCL \longrightarrow CaCl_2 + H_2O + Co_2$

Variables:
The variables in this investigation were the mass of the marble the concentration and volume of Hydrochloric acid. In this investigation I will keep changing the concentration of Hydrochloric acid to test how much Carbon Dioxide (Co_2) gas is formed. You can also change the marble from powered kind to larger pellet kind, but my group used powered kind and stuck with it. Also you can have the temperature as a variable, which in most people's cases will always be changing.

To make this investigation a fair one. I will change the conical flasks by washing each one, in case there are other types of chemicals inside the flask that could affect the marbles rate of reaction, this also could cause errors in my results. I will also try to get the weight of the marble as precise as I can, and keep it at 1 gram.

Prediction:
I predict that the higher the concentration of Hydrochloric acid the greater the volume of Carbon Dioxide (Co_2) gas formed, but of if for example the concentration of Hydrochloric where to decrease, then so would the volume of Carbon Dioxide (Co_2) gas coming out. I believe this to be correct because if you refer back to my theory you would see that increasing the concentration of acid is one of the ways of speeding up the rate of reaction. The particles inside the liquid increase in amounts, which therefore mean there is a lot more chance of the Hydrochloric acid reacting with the marble. My prediction can be affected by faulty equipment of if the Variables get changed dramatically.

Safety Points:
To make sure no one gets hurt during this investigation I will always wash my hands before and after the practical part, I will wear goggles throughout the experiment, and I will never run around in class while experiments are in progress.

Method:

Fig.1

Gas Cylinder

Conical Flask

Clamp and Stand

Weighing machine

Goggles

Stop Clock

I first began this experiment by setting up the apparatus shown in fig.1.
In my preliminary work I learned that doing this investigation would be the most interesting and would give me the most results. This is because the other two types of Investigations only gave you how long it took to dissolve the marble in Hydrochloric acid, where as this one not only tells you the time it takes to dissolve marble in Hydrochloric acid, but it also gives the amount of Carbon Dioxide (Co_2) gas formed during the experiment. Which gives us more information about marble and Hydrochloric acid.
We first began with 0.25M concentration of Hydrochloric acid. We then put that in the conical flask and weighed out 1g of calcium carbonate (marble), then put that into a beaker. Then while one person put the calcium carbonate (marble) into the conical flask with putting the cork on so it is air tight, with the Hydrochloric acid another person turned on the stop clock. Then we just waited to see how fast the reaction took place by measuring the amount of Carbon Dioxide (Co_2) gas made every ten seconds that went by. We continued to measure it until there was 100cm gas made, at which point the cylinder was full of carbon dioxide (Co_2) gas. We then did this again with 0.5, 0.75 and 1m acids so that we had all four types of results. We then did and extra part at the end before we drew our graphs, which was 0.8 so this way our results would be more accurate on how increasing the concentration, effects the rate of reaction.

Conclusion:

In this investigation I learned that the higher the volume of acid used to dissolve calcium carbonate powder ($CaCo_3$) the greater the volume of Carbon Dioxide (Co_2) gas was formed in cm. A strong example of this is in my results, which show that 0.25 of acid to let out 55cm of Carbon Dioxide (Co_2) gas in 2 minutes, also shows that that the concentration of gas is so weak that it did not even managed to fill the cylinder. Where as 0.75 filled the gas cylinder with Carbon Dioxide (Co_2) gas in 50 seconds. This now clearly shows that the higher the concentration of acid the greater the volume of gas made.

This happens because the higher the concentration of acid the more particles there are to react with the marble. To cause not only a quicker rate of reaction, but because the hydrochloric acid can be stronger and react with the marble quicker it causes the carbon dioxide to come out at a much more greater speed in a bigger amount over all.

E.G

Weaker concentration reacting
With the marble at a slower speed
Causing the gas to come out at a slower rate
This was what was happening with the
Weaker concentrations (e.g. 0.25m and
0.5m)

Stronger concentration reacting at a much faster rate causing the gas to come out at a much faster rate.
This was what was happening with the stronger acid concentrations (e.g. 0.8m and 1m)

Also of course there was a very easy pattern to notice in my results, and that was the higher the concentration of hydrochloric acid the greater and quicker the carbon dioxide (Co_2) gas is made. This pattern that I noticed is endless when you think about it because you can't change it. If the concentration becomes stronger then the carbon dioxide (Co_2) gas will come out at a greater and faster rate. Where as if the concentration is weaker then the carbon dioxide (Co_2) gas will come out at a less amount and slower rate.

Lastly all of this proves that my prediction is correct in saying that the higher the concentration of hydrochloric acid (HCL) the greater and faster the carbon dioxide (Co_2) gas will come out.

Evaluation:

This investigation was very interesting and I learned quite a lot about it, it was also quite enjoyable and was done in quite a good way the cylinder (syringe) was used and all the other small bits like clamp and stand.

The results I got from my investigation where not all that accurate but they where good enough to give you a reasonable amount of information. Also to prove that the results where not that accurate there was and error in them. This occurred when we had decided to use 0.8m concentration of acid after we had used all the other concentrations. I'm not to show what exactly happened but the speed of the carbon dioxide (Co_2) gas seemed to slow down then speed back up to normal rate with 0.8m. What possibly could have happened was that there could have been some left over acids in the equipment I was using.

There was many ways that could have been done to improve our investigation and make our results more accurate, one way is quite obvious and that is just to repeat our results more times so we would have more of them when we refer back to them. But also we could have increased the size of the cylinder (syringe) so that way we could not only get more carbon dioxide in the tube to give more results, but also we could test for more higher concentrations of acid because we had more space in the cylinder for gas. Also if you wanted to get loads of results and want to know a lot about marble (calcium carbonate) then you could use different types of acid like sulphuric acid or nitric acid, this way you could test the rate of reaction with different acids and would give you loads more results and information.

But all in all I do think that this investigation was good enough and gave me enough results to tell me that the higher the concentration of acid the quicker the marble will dissolve.